DOCUMENT RESUME

ED 153 802 SE 023 980

AUTHOR Wooding, N. Henry
TITLE Home Sewage Disposal. Special Circular 212.
INSTITUTION Pennsylvania State Univ., University Park. Coll. of Agriculture.
PUB DATE [77]
NOTE 24p.; For related documents, see SE 023 978-981

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Environment; *Environmental Criteria; *Home Management; Pollution; Sanitation; *Waste Disposal; Water Pollution Control
IDENTIFIERS Pennsylvania

ABSTRACT

This circular provides current information for homeowners who must repair or replace existing on-lot sewage disposal systems. Site requirements, characteristics and preparation are outlined for a variety of alternatives such as elevated sand mounds, sand-lined beds and trenches, and oversized absorption area. Diagrams indicating construction requirements are included. (CS)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

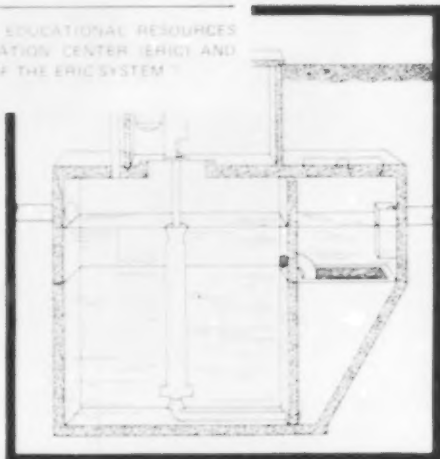
N Henry Wooding

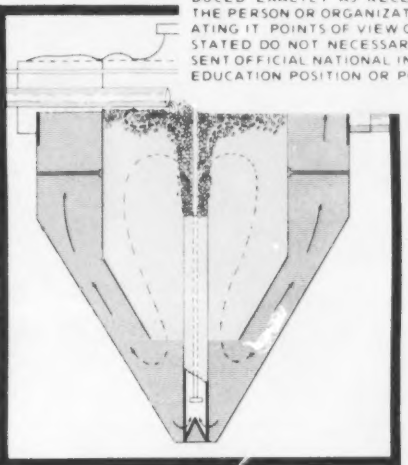
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM.

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

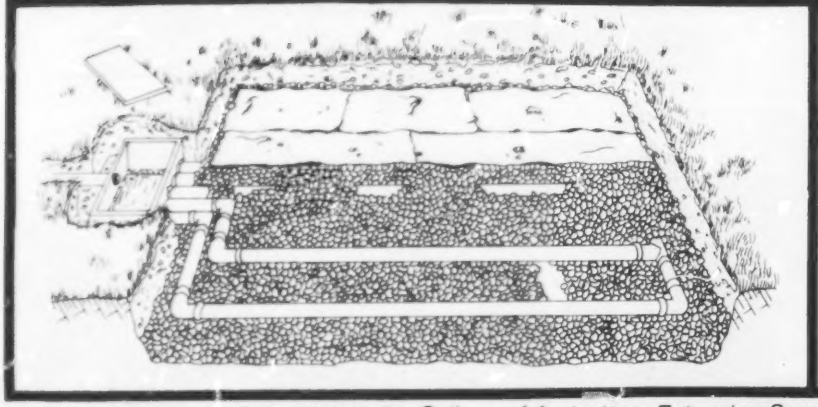
ED153802

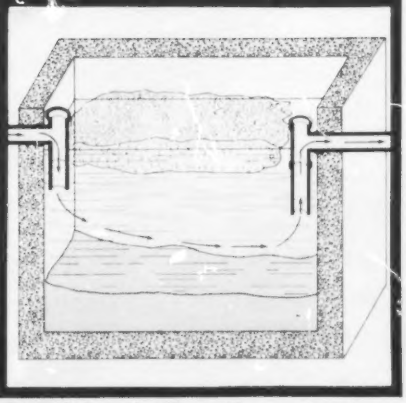




HOME SEWAGE DISPOSAL

Special Circular 212





The Pennsylvania State University, College of Agriculture Extension Service, University Park, Pennsylvania

SE 023 980

CONTENTS

RULES AND REGULATIONS 1
Sewage-disposal permits
Penalty for violations

PRINCIPLES OF ON-LOT SEWAGE TREATMENT 1
Primary treatment
Secondary treatment

SUITABILITY OF LAND FOR ON-SITE SEWAGE DISPOSAL 2
Site evaluation for effluent disposal
Soil-profile inspection
Soil-percolation tests

HOW TO MAKE SOIL-PERCOLATION TESTS 3
Prepare test holes
Saturate the soil
Determine the percolation rate

SITE PLANNING FOR SEWAGE DISPOSAL 4
Location of the treatment tank
Effluent-disposal area
Space required for effluent disposal
Use an average percolation rate

TREATMENT TANKS AND PROCESSES 5

THE SEPTIC TANK PROCESS 6
Liquid capacity of a septic tank
Types of septic tanks used

HOW TO CONSTRUCT A SEPTIC TANK 7
Excavation
Inlet and outlet
Concrete slab top
Manhole for sludge removal

SEPTIC TANK MAINTENANCE 7
How to measure the depth of scum and sludge
Chemical compounds

AEROBIC-TREATMENT PROCESS 8
Maintenance of aeration tanks

EFFLUENT TREATMENT AND DISPOSAL 10
Distribution box
Standard trench disposal system
How to construct standard trenches
Effluent-seepage bed
Serial distribution
How to design a serial-distribution system

ALTERNATE METHODS OF EFFLUENT DISPOSAL ...14
Elevated sand mound
Sand-lined beds and trenches
Oversized absorption area
Shallow placement absorption area

THINGS YOU SHOULD KNOW ABOUT SEWER LINES 18
Tile or concrete pipe
Plastic pipe
Y-branch cleanout
Make a sketch of your underground system

REFERENCES 18

GLOSSARY 19

N. Henry Wooding, Extension Agricultural Engineer

Printed in cooperation with Bureau of Community Environmental Control, Pennsylvania Department of Environmental Resources

This publication supersedes Special Circular 92, Home Sewage Disposal Methods and Techniques

The Cooperative Extension Service offers educational programs and materials without regard to sex, race, age, color, or national origin and is an Equal-Opportunity employer.

Issued in furtherance of Cooperative Extension Work, Acts of Congress May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture and the Pennsylvania Legislature. J. M. Beattie, Director of the Cooperative Extension Service, The Pennsylvania State University.

HOME SEWAGE DISPOSAL

RULES AND REGULATIONS

The Sewage Facilities Act as amended (Act 537) is the basic law governing home sewage disposal in Pennsylvania. The Department of Environmental Resources (DER) is the state agency responsible for the administration of the act and the implementation of sewage-related programs and activities. The rural area sewage program is based on comprehensive municipal planning and uniform standards for the construction of individual on-lot sewage-disposal facilities. Responsibility for this program has been delegated to the municipalities and is administered primarily through the use of municipal sewage-disposal permits.

Sewage-disposal permits

Permits are required for all individual on-lot sewage disposal systems except rural residences, unless there is a local municipal ordinance that supersedes this exception. A rural residence means a structure occupied or intended to be occupied by not more than two families on a tract of land 10 acres or more in size.

If you are planning to purchase land on which to build a house, to install a new sewage-disposal system on your lot, or to make changes in an existing sewage-disposal system, you should apply for a sewage-disposal permit before you enter into any purchase agreement or binding contract, even though you might find out later that a permit is not required.

The only person who can issue a permit is a Sewage Enforcement Officer (SEO) certified by the DER Certification Board and designated by municipal ordinance as the SEO for the *municipality* or *local agency* having jurisdiction in the area.

The application for a permit is a standard DER form and can be obtained from any certified sewage-enforcement officer. Fill in the application and return it with the required fee to the sewage-enforcement officer in your municipality. If the plan for the proposed treatment system meets required standards, the application will be approved and a permit will be issued authorizing construction. If the permit is denied, the decision may be appealed by submitting a written request to the local agency for a hearing at which evidence may be presented for further consideration.

Penalty for violations

The Sewage Facilities Act and regulations governing permits and standards for sewage-disposal facilities are clear and specific. Construction and installation of a sewage-disposal system without the required permit may lead to arrest, conviction, and a severe penalty.

PRINCIPLES OF ON-LOT SEWAGE TREATMENT

Primary treatment

The initial treatment or decomposition of raw sewage occurs in the treatment tank. The process includes dilution, mechanical degradation, settling, and biological digestion. The purpose of primary treatment is to separate solids from liquid and condition the liquid for final treatment and disposal in a subsurface soil absorption area.

Secondary treatment

The second phase of treatment occurs after the liquid is discharged from the treatment tank and absorbed by the soil in the disposal area. Soil organisms and chemical processes in the soil renovate the sewage effluent chemically, physically, and biologically. Ultimately, the renovated effluent becomes diluted in the groundwater.

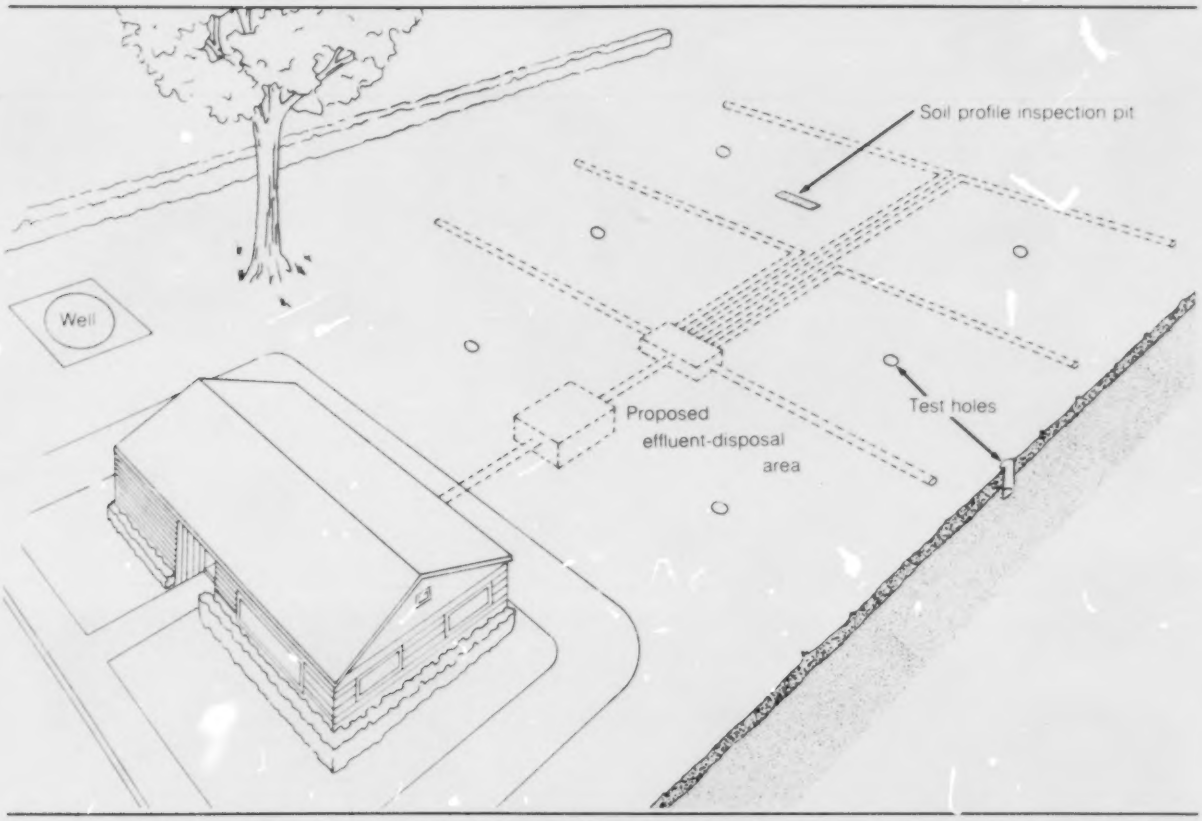


Figure 1 Select the best-drained area for effluent disposal. Dig a soil-profile inspection pit and make soil-percolation tests.

SUITABILITY OF LAND FOR ON-SITE SEWAGE DISPOSAL

Soil scientists with the USDA Soil Conservation Service and the DER estimate that less than 20 percent of Pennsylvania's land areas are suitable for on-lot sewage disposal. Approximately 38 percent are considered marginal, and the remaining 42 percent totally unsuitable.

General information about soil types, erosion, and drainage characteristics of much of Pennsylvania's land areas can be obtained from the county soil-survey report. This report includes maps and aerial photographs on which soil boundaries have been drawn, and the soils within these boundaries have been identified. Most Pennsylvania soils have been classified as to their suitability for specific uses, including sewage-effluent disposal. Copies of recently published soil-survey reports may be available for study and review in county offices of the Pennsylvania Cooperative Extension Service, the Soil Conservation Service (SCS), and the Conservation District. If the report has not been published for your county, information about the soil on your lot may be available from the SCS soil scientist working in the area.

A potential home builder cannot depend entirely on the information published in the Soil Survey Report. The scale of aerial photographs used as base maps for soil boundaries is too small to identify most building lots, and as a result each lot should be inspected and evaluated to determine the suitability of the soil for sewage disposal.

Site evaluation for effluent disposal

Every building lot for which on-site sewage disposal is proposed must be investigated and evaluated by the sewage-enforcement officer before he can issue a sewage-disposal permit. The evaluation is based on a *soil-profile inspection* to locate *limiting zones*, and *percolation tests* to determine how fast the sewage effluent will move down through the soil.

A limiting zone is any soil horizon that will severely limit the soil's capability to renovate sewage effluent or liquid discharged into the absorption area. This can be a seasonally high water table (indicated by mottling in the soil), a layer of bedrock, a fragipan layer, open-jointed or

fractured rock, or a layer of gravel. A shallow soil with a fragipan or bedrock limitation could prevent the vertical movement of effluent and create health hazards by forcing polluted water to the surface. Fractured rock or a gravel layer may let the effluent percolate downward so rapidly that it will contaminate the groundwater.

The depth of a subsurface limiting zone in a proposed effluent-disposal area determines to some extent whether a *conventional method* or an *alternate system* of effluent disposal will be permitted.

Conventional methods of effluent treatment and disposal involve *standard trenches, seepage beds,* and *subsurface sand filters*. If soil and site conditions prohibit use of the conventional methods, the sewage-enforcement officer may suggest an alternate effluent-disposal system.

Alternate systems that have been recognized and approved by DER include *elevated sand mounds, sand-lined trenches and beds, oversized absorption areas,* and *shallow placement areas*.

Soil-profile inspection

A pit or trench should be excavated to a depth of 7 feet or to the soil or rock layer that may act as a limiting zone in the disposal area. The pit must be wide enough for the sewage-enforcement officer to examine the soil profile, identify soil horizons, and evaluate the suitability of the soil for sewage disposal.

An inspection pit can be dug with hand tools, but a backhoe can open a trench much more quickly and with much less effort. In some instances, more than one trench may be required to verify conditions in a questionable area. The sewage-enforcement officer must make this inspection.

Soil-percolation tests

Percolation tests must be performed to determine how many square feet of absorption area will be required to absorb the sewage effluent discharged from the treatment tank. These tests must be conducted in the presence of the sewage-enforcement officer or under his direction.

HOW TO MAKE SOIL-PERCOLATION TESTS

Select and mark positions for six or more percolation test holes in the proposed effluent-disposal field. The sites selected for these test holes should be spaced uniformly over the entire area. Test holes should be 4 to 12 inches in diameter and about 30 to 36 inches deep.

Prepare test holes

Scratch the sides and bottom of each hole with a knife or other pointed instrument to eliminate the glazed condition of the soil surface. The test hole should have a natural soil interface into which the water can move vertically or laterally. Remove all loose soil from the hole. Add about 2 inches of clean coarse sand or gravel to protect the bottom from scouring and to prevent sediment from plugging the tiny spaces between soil particles.

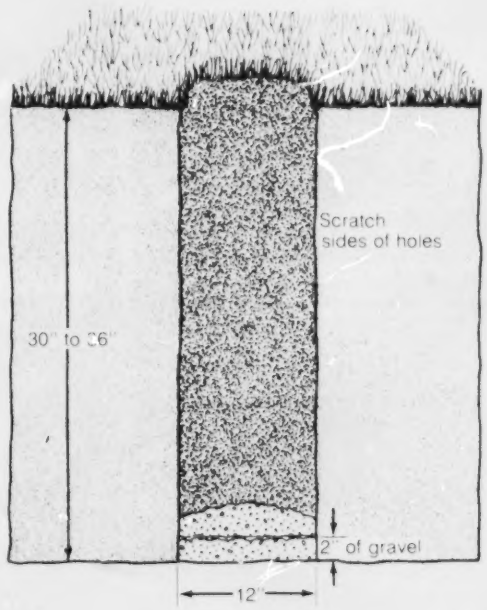


Figure 2 Soil-percolation tests should be conducted under conditions which are similar to those existing in the soil during the wettest season.

Saturate the soil

Fill the hole with clean water so the surrounding soil becomes saturated. It is important to distinguish between saturating and swelling. In saturated soil, all spaces between soil particles are full of water. Saturation occurs within a few minutes after water is put into the hole, but swelling takes longer.

Swelling is caused by the intrusion of water into the individual soil particles. It is a slow process — especially in clay soil — and may take 12 to 24 hours or longer. Wait for the particles to swell in order to make a fair percolation test.

During the saturating and swelling process, much of the water will percolate down into the soil. Try to maintain a minimum depth of 12 inches over the gravel during this period. If the soil is sandy, keep water in the hole at least 4 hours. If the soil is a loam or clay loam,

keep water standing in the hole overnight.

It takes time for soil particles to swell and approach conditions present in the disposal field during the wet-test season. Except in sandy soil, the particles should swell for about 24 hours before the percolation rate is determined.

Determining the percolation rate

If water remains in the test hole after the 24-hour swelling period, adjust the depth to approximately 6 inches over the gravel and prepare to test. Measure the distance from the reference point (Fig. 3) to the surface of the water, and measure it again in 30 minutes. Record the number of inches the water level drops during the 30-minute period. Divide 30 by the number of inches dropped. The result (time required for the water level to drop 1 inch) is the percolation rate. Record this figure for future reference.

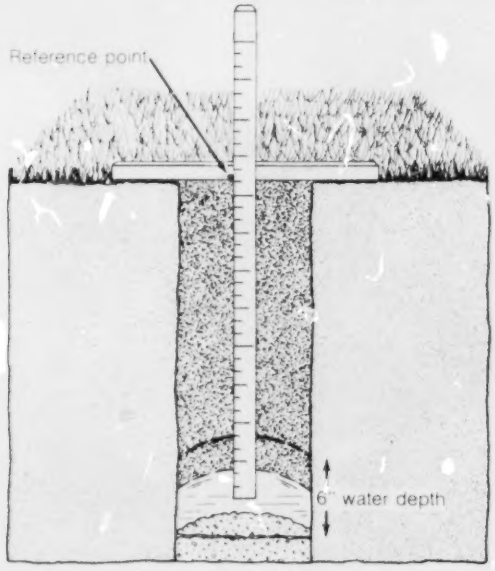


Figure 3 Measure distance that the water drops from a fixed reference point.

If no water remains in the hole after the swelling period, add clean water to bring the level up to 6 inches over the gravel. From the fixed reference point measure the drop in the water level at 30-minute intervals for 4 hours, adding water after each measurement to maintain a depth of 6 inches over the gravel. Use the number of inches dropped during the final 30 minutes to calculate the percolation rate.

In sandy soil or other soil in which the first 6 inches of water seep away in less than 30 minutes after the overnight swelling period, add enough water to bring it up to the 6-inch level. At 10-minute intervals during a period of one hour, measure accurately the distance down to the water; add more water after each measurement to bring the level back to 6 inches above the gravel. Record the number of inches the water level drops during the final 10 minutes. Divide the last time period by the final distance to determine the percolation rate in minutes per inch.

SITE PLANNING FOR SEWAGE DISPOSAL

Location of the treatment tank

The site for the treatment tank should be on high ground and at least 10 feet from the building and 50 feet from the well or other source of drinking water.

Sewage should flow by gravity from the house to the tank and on to the effluent-disposal field. If the laundry drain is lower than the treatment tank, laundry waste can be elevated with a sump pump. It is more difficult to pump human waste with its solids than it is to pump dirty laundry water.

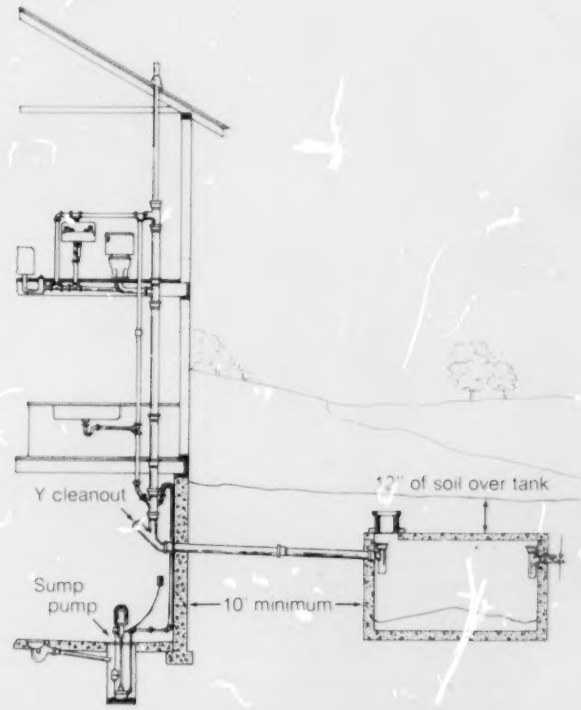


Figure 4 Use a sump pump to lift laundry waste water to a septic tank located above the basement floor level.

The treatment tank should be located in a convenient area where it can be opened for inspection and cleaning. Do not place it under a porch or patio or in an area subject to run-off from streets, gutters, and downspouts. It should be accessible to a driveway so that a tank truck can get close enough to remove the sludge when necessary.

Effluent-disposal area

The effluent-disposal area should be located a safe distance down slope from the well or spring. Avoid natural depressions that may be wet due to subsurface seepage or drainage from downspouts, road ditches, or a neighbor's lot. Soil in a low area saturated with natural run-off will not absorb the sewage effluent from the treatment tank. Try to avoid any area with a potential high-water table, impermeable bedrock, or other limiting zone that may impair the absorption process.

Low areas that have been filled to increase the elevation of the lot must not be considered unless the fill has been in place for at least 4 years.

Do not locate the disposal area adjacent to a stream bank or on a gravel bed. Avoid discharging the sewage effluent into a sinkhole, where it might contaminate drinking water. Plan the location of the standard trenches or seepage bed with due consideration for minimum isolation distances (Table 1).

	Feet
Well, spring, or pump suction line	100
Stream, lake, or pond	50
Water line under pressure	25
Property line or occupied building	10
Drip area of trees	10

Table 1. Isolation distances for effluent-disposal areas.

Space required for effluent disposal

An on-lot sewage-disposal system may occupy the major portion of a typical building lot. Depending upon topography, soil characteristics, type and design of the system, and size of the home, an area ranging from 2,000 to 5,000 square feet may be required. Use of an alternate system carries the additional requirement of having a lot large enough to construct an additional seepage area of equivalent size if the need should arise.

The type of treatment tank used, soil-percolation rate, and the number of bedrooms in the home are primary factors used to determine the number of square feet required in the bottom of the standard trench or seepage bed. Effluent from a septic tank has more pollution potential than effluent from an aerobic treatment tank, and experience indicates that septic tanks require approximately 30 percent more absorption area.

Use an average percolation rate

Combine percolation-test data for all test holes on the lot to compute the average percolation rate for the area, then refer to Table 2 to determine how many square feet of absorption area will be required. If the average percolation rate is 6 to 15 minutes per inch, you should have no trouble with a properly designed and constructed effluent-disposal field. If the rate ranges from 30 to 60 minutes per inch, a larger disposal area will be required.

If the percolation rate is less than 5 minutes per inch, or more than 60 but less than 90 minutes per inch, and a conventional system is not permitted, the sewage-enforcement officer may recommend an alternate system of effluent disposal.

	Absorption Area Required** (sq. ft./bedroom)	
Percolation Time* (minutes)	Septic Tank	Aerobic Tank
0 to 5	Unsuitable	Unsuitable
6 to 15	175	120
16 to 30	250	170
31 to 45	300	200
46 to 60	330	220
61 to 90	Unsuitable	425
91 or more	Unsuitable	Unsuitable

* Time required for water to fall one inch.

** Divide figures in these columns by 1.5 to determine the length of trenches 18 inches wide, or by 3.0 for length of trenches 36 inches wide.

Table 2. Net absorption area required for effluent disposal using standard trenches or seepage beds.

TREATMENT TANKS AND PROCESSES

Two types of tanks used for the primary treatment of home sewage are the *septic tank* and the *aerobic tank*. A septic tank requires very little attention to keep it working properly. It is primarily a settling tank and does not remove all impurities nor make pure water from sewage. The aerobic tank includes an electrical-mechanical component that requires routine checking and regular service. It provides a higher degree of sewage treatment, removes more organic solids, and discharges a much cleaner effluent than the septic tank, but the liquid is still sewage and must be discharged to a subsurface absorption area.

THE SEPTIC TANK PROCESS

A septic tank is a watertight vault or tank that receives raw sewage from the bathroom, kitchen, and laundry drain. Sewage held in the tank for a short period of time undergoes primary treatment or a natural conditioning process. Three things happen while it is in the tank:

Solids are separated from the liquid. Baffles or special pipe fittings in each end of the tank reduce the liquid velocity and prevent the sewage from flowing directly through it. In this semi-quiet environment the heavier solids sink to the bottom. These are called "settled-solids." The lighter particles, including grease and foam, rise to the surface and form a mat of partially submerged floating solids called "scum."

Bacteria decompose the solids. Anaerobic bacteria (a family of organisms that live without oxygen) digest some of the grease and heavy solids. The decomposition of these solids without oxygen releases a foul-smelling gas, and the digestive process is termed septic — hence the name "septic tank."

In the process some solids are liquified, but the residual products settle to the bottom as an inactive mass called "sludge." The gas escapes through the main sewer and is discharged into the atmosphere through a pipe installed through the roof of the house. The partially conditioned liquid flows out of the tank and into the disposal area where it is absorbed by the soil.

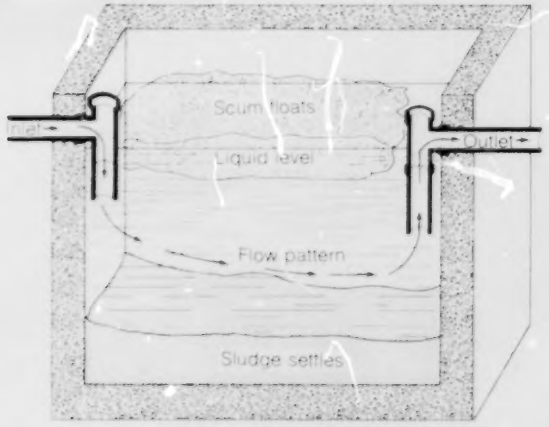


Figure 5 In the septic tank, heavy solids settle to the bottom, scum floats on top, and liquid is discharged through the outlet to the effluent-disposal area.

Sludge and scum are stored. Solids and scum that are not liquified remain in the septic tank. No matter how efficient the digestive process may be, sludge settles in the bottom of the tank and, in time, will have to be taken out and hauled away. If not removed, this residual material will accumulate until it eventually fills the tank, overflows into the disposal area, and ruins the effluent-absorption system.

Liquid capacity of a septic tank

Studies have shown that liberal tank capacity is important both functionally and economically. The tank should be large enough to store the sludge and scum for two or more years without cleaning. Pennsylvania DER regulations base the capacity of the tank on the number of bedrooms in the home. The smallest tank permitted must have a capacity of 900 gallons.

Number of Bedrooms	Minimum Capacity (gallons)	Approximate inside dimensions of rectangular tanks		
		width	length	depth
3 or less	900	4'0"	7'6"	5'0"
4	1000	4'0"	8'4"	5'0"

For each additional bedroom add 100 gallons to the minimum capacity, or about 8 inches to the length indicated.

Table 3 Liquid capacity of septic tanks for homes.

Types of septic tanks used

Experience indicates that it may be more convenient and economical to install a precast concrete septic tank than to construct your own. In most areas of the Commonwealth you can purchase tanks of good quality from local dealers or contractors. The purchase price usually includes delivering the tank to the site and placing it in the excavation provided by the builder.

Cylindrical steel tanks meeting commercial standard no. 177-62 of the United States Department of Commerce are acceptable. These tanks should be coated outside with asphalt to prevent corrosion. If a cylindrical tank is placed in the horizontal position, the normal liquid depth should not exceed 80 percent of the diameter of the tank.

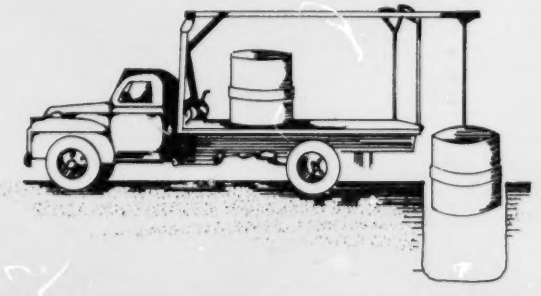


Figure 6 Precast septic tanks are practical and economical. Local dealers usually have several sizes in stock.

HOW TO CONSTRUCT A SEPTIC TANK

If a homeowner decides to construct a tank himself, he must use reinforced concrete. Brick and masonry-block tanks are not permitted. The required liquid capacity and the approximate inside dimensions of the tank can be determined from Table 3.

Excavation

Dig a hole about 2 feet wider, longer, and deeper than the inside dimensions of the tank. The exact depth will depend upon the elevation of the outlet with respect to the depth of the tile lines in the absorption area. Remember that the effluent should flow by gravity from the tank to the tile disposal field. The completed installation should have room for at least 1 foot of soil on top of the tank.

Inlet and outlet

Place a short section of cast-iron soil pipe in each end wall to provide an inlet for the sewage and an outlet for the effluent. Attach tee sections of soil pipe to both the inlet and outlet, as shown in Figure 7. These pipes will serve as baffles preventing the direct flow of liquid through the tank. Leave at least an inch of air space between the top of the tee and the underside of the slab covering the tank. The discharge end of the pipe should be about 12 inches below the liquid surface so as to direct incoming sewage into the bottom of the tank without disturbing the mat of floating scum.

The tank's outlet should be at least 3 inches lower than its inlet. The vertical extension of the tee should penetrate about 40 percent of the liquid depth to prevent the scum from flowing out of the tank and into the effluent-disposal system.

Concrete slab top

Cover the tank with removable steel-reinforced concrete slabs. A simple form made of 2 by 4 lumber and exterior-grade plywood may be used to cast the slab in small portable sections. Be sure to reinforce each slab with two or more 3/8-inch steel rods. Place U-shaped rods near the ends for lifting handles. It may be more economical to purchase the slabs from a concrete dealer.

Manhole for sludge removal

If the concrete slab is constructed in one piece, be sure to provide 20-inch manholes over the inlets and outlets for inspection and sludge removal. They should terminate 12 inches below ground level or have extensions to the surface fitted with airtight covers.

If the top is made of removable concrete slabs, manholes are not necessary, but a large tile or pipe extension should be placed in one of the slabs near the inlet tee to provide a convenient access for measuring the depth of sludge and scum.

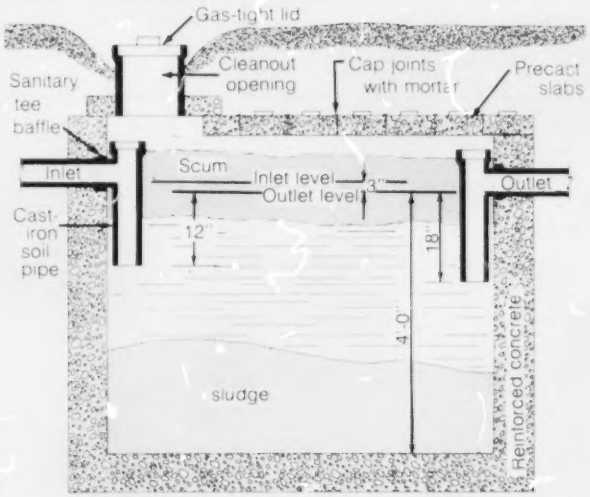


Figure 7 Install sanitary tees or baffles to control turbulence and protect the outlet. Provide a convenient opening near the inlet for inspection and cleanout.

SEPTIC TANK MAINTENANCE

In every properly functioning septic tank, sludge accumulates in the bottom. This sludge does not become liquid and must be removed. Do not put this job off until the tank and the sewer fill up and the toilet overflows on the bathroom floor. If this happens, a new effluent-disposal system may have to be installed.

How to measure the depth of scum and sludge

Septic tanks should be opened and inspected once each year. The scum can be measured with a stick and hinged-flap device (Fig. 8). Push the stick through the scum until the hinged flap falls into the horizontal position. Raise the stick until you can feel the bottom of the mat. Mark the stick to indicate the depth of the scum layer. Now use the same procedure to locate the lower end of the submerged inlet pipe. If the bottom side of the scum layer is within 3 inches of the lower end of the submerged inlet, the tank should be cleaned.

To measure the depth of sludge, wrap a long stick with a piece of rough white toweling and tie it securely. Lower the measuring stick through the inlet tee (to avoid the scum) to the bottom of the tank. Wait a few minutes and remove the stick slowly and carefully. The depth of sludge can be distinguished from the liquid by the black particles clinging to the toweling. The sludge should be removed if its depth is equal to one third or more of the liquid depth.

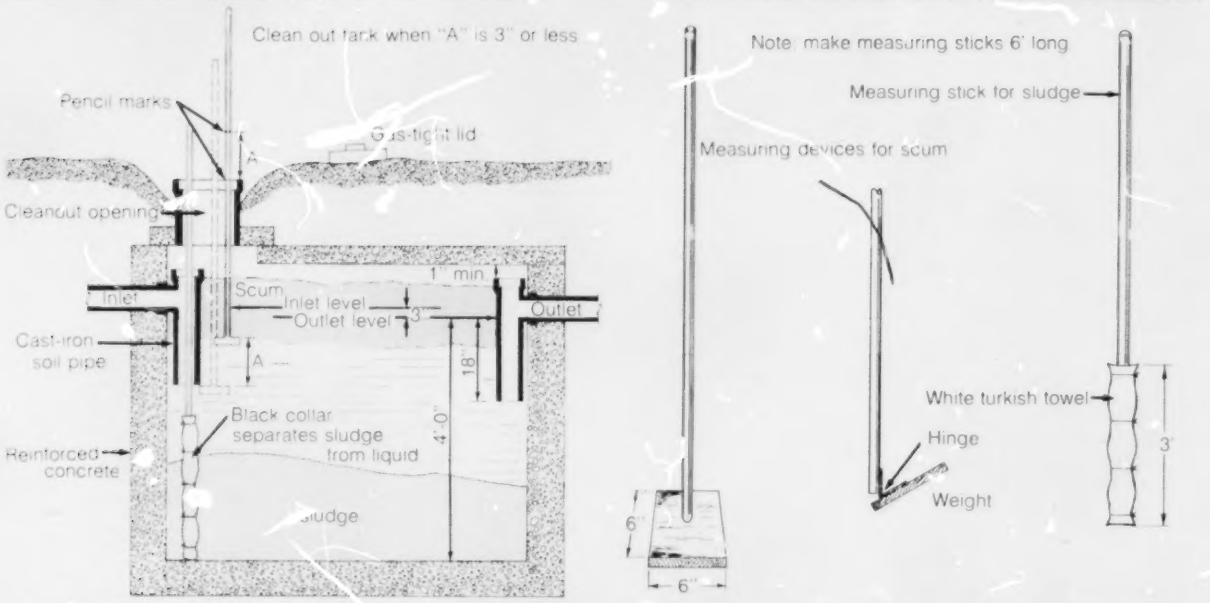


Figure 8. Check the thickness of the layer of scum and the depth of sludge to determine when to clean the septic tank. Depth of sludge will be indicated by black particles clinging to white toweling.

How often will you need to clean your tank? This depends on its capacity and the amount of solid material it accumulates. Most authorities agree that for a typical home, a 900-gallon tank will need to be cleaned every 3 to 5 years. Smaller tanks must be cleaned more often. The liquid capacity of septic tanks indicated in Table 3 permits the use of garbage disposal units and automatic washing machines.

Most communities have contractors who clean septic tanks. They pump the contents into a tank truck and haul it away. Be sure the workman who cleans your tank mixes the liquid, sludge, and scum before pumping. All material should be removed (not just the liquid). This material should be buried, or discharged into a treatment plant. It should never be dumped in a sinkhole, storm drain, or left where it may drain into a stream or any source of drinking water.

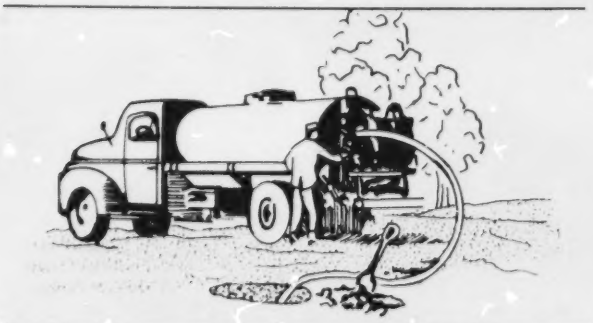


Figure 9. The contents of the septic tank should be pumped out and hauled away. Be sure sludge as well as the liquid is removed.

Many disagreements and unhappy circumstances can be avoided if you have an understanding with the contractor before he starts to work. He should know what you expect him to do, and you should understand what he expects to be paid.

Chemical compounds

You cannot improve the biological activity in the septic tank by using chemical compounds, enzymes, or other preparations sold for this purpose. Some products which the manufacturers claim will "clean" a tank may contain compounds that will adversely affect the sewage treatment and produce an effluent which will destroy soil structure and cause premature failure of the soil absorption system.

AEROBIC-TREATMENT PROCESS

In the aerobic-treatment process, a mechanical aeration tank is used. It is similar to a septic tank, but the biological activity in the tank is quite different. The treatment is somewhat similar to that which occurs in an extended-aeration municipal treatment plant.

The function of an aerobic-treatment tank is to decompose the sewage and "wet burn" the solids that would otherwise accumulate as sludge in a septic tank. In aerobic treatment, free air is admitted to the tank

through an opening on top or forced in by an air blower or compressor. An electric motor with some type of on-off control mechanism circulates the sewage or drives a rotor that mixes the air with sewage in the tank. In some aerobic units the air is forced through aerators or air diffusers submerged in the liquid near the bottom of the tank.

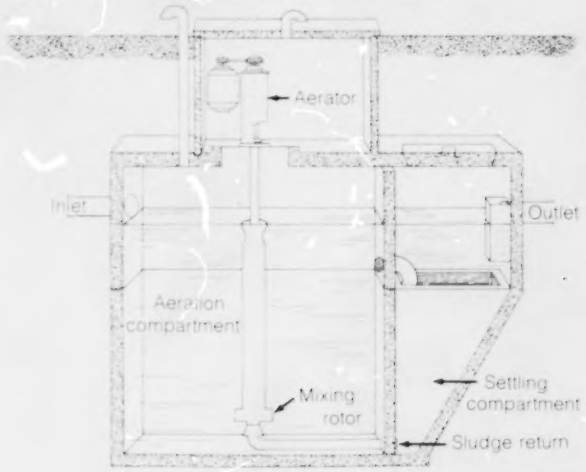


Figure 10 An aeration tank contains a mechanical aerator that must be inspected and serviced.

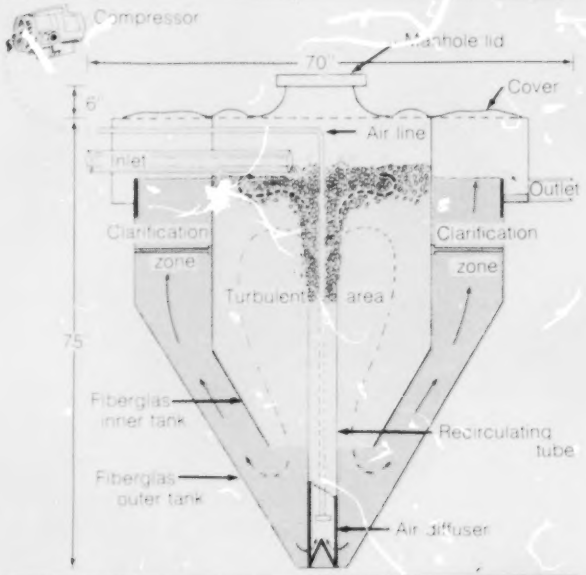


Figure 11 Sewage treated in an aerobic tank requires a smaller subsurface effluent disposal system.

Oxygen from the air supports the activity of aerobic bacteria that digest the sewage and liquify most of the solids. Sludge which accumulates in the settling compartment of a two-compartment tank returns to the aeration compartment for further treatment. In a single-compartment tank a small amount of sludge will accumulate in the bottom of the tank and, in time, will have to be removed.

The biological activity and digestive process in an aeration tank are much more efficient than those in a septic tank. Normally, the effluent is cleaner, and it has little or no odor. It is still sewage, however, and contains disease-producing organisms. This effluent should be discharged to a subsurface-disposal area where final purification will take place in the soil. Since the effluent is much cleaner and contains less sludge, the effluent-absorption area for an aerobic unit can be about two-thirds that for a septic tank.

If you plan to install an aerobic-treatment tank as part of your on-lot sewage-disposal system, be certain that you understand its advantages and disadvantages. Remember also that the effluent must be discharged to a subsurface-absorption system. Do not be misled about how much more satisfactorily and efficiently an aerobic unit will dispose of sewage from your home. If the problem is tight soil, a high water table, or a slow percolation rate, installation of an aerobic-treatment tank is no help.

Be sure that the unit you plan to purchase meets the requirements of "Standard 40" of the National Sanitation Foundation (NSF) and carries the NSF testing laboratory seal of acceptance (Fig. 12). Aerobic units without the NSF seal must be approved by the Department of Environmental Resources.

Standards for aerobic sewage treatment units

Aerobic sewage treatment tanks or separate aerobic treatment units approved for use in Pennsylvania must conform with National Sanitation Foundation Standard 40, dated November 13, 1970. Such equipment must either

a. bear the NSF seal or

b. be approved by DER based on tests conducted by an approved testing agency in accordance with Standard 40.

Figure 12 NSF Testing Laboratory Seal.

Maintenance of aeration tanks

An aeration-treatment system includes mechanical components that, like most mechanical appliances, require periodic maintenance and service. These components can break down or wear out, and will have to be replaced. Each unit should be serviced and maintained according to the manufacturer's recommendations. A written service contract should be obtained from the local dealer. Be sure that he keeps replacement units in stock and that he can be relied upon to repair your unit quickly and satisfactorily. If the unit stops working, the treatment process will become septic and the tank will function as an undersized septic tank. Continued use of the unit as a septic tank will result in the rapid accumulation of sludge, and if it overflows into the tile lines the entire effluent-absorption system may have to be replaced.

EFFLUENT TREATMENT AND DISPOSAL

Effluent disposal is the most important aspect of on-lot sewage treatment. No home-sewage treatment facility makes pure water out of sewage. Although the effluent from the treatment tank can be relatively clear, it contains many dangerous disease organisms, and must be disposed of beneath the surface of the ground.

Soil surveys indicate that much of the land in Pennsylvania is totally unsatisfactory for effluent disposal. A potential homeowner or builder should find out whether his proposed home site is suitable for on-lot sewage disposal before he purchases the land.

The methods of effluent disposal currently authorized by the DER include conventional methods and alternate systems. Conventional methods are standard trenches, seepage beds, serial-distribution systems, and subsurface sand filter systems. Alternate systems include elevated sand mounds, sand-lined beds and trenches, oversized areas, and shallow placement areas.

All effluent-disposal systems should be located in cleared areas, so that sunlight and free-air movement can help evaporate moisture from the soil.

The size of the absorption area depends on the type of treatment tank to be installed, the number of bedrooms in the home, and an evaluation of soil conditions on the site, including a soil-profile inspection and percolation tests.

The effluent-disposal facility includes a distribution system of perforated pipe or open-joint tile to distribute the effluent uniformly throughout the absorption area. Most conventional methods of effluent disposal include a distribution box to divide the flow of liquid equally to all pipelines in the effluent-disposal area.

Distribution box

The distribution box is a tank-like box with an inlet and as many outlets as there are lateral distribution lines in the absorption area. Each outlet should be connected to a pipeline that conveys effluent to one of the standard trenches or to a lateral line in the seepage bed. Equal flow to all distribution lines is necessary to prevent one trench or one line from becoming overloaded while another remains unused. A distribution box is not required for serial distribution.

The box should be placed on a level concrete foundation below the frost line so that the position of the outlets will not be affected by the heaving of freezing soil. The outlets should be at least 4 inches above the bottom of the box so that sludge escaping from the treatment tank can be trapped and prevented from flowing directly into the distribution lines in the absorption trenches. The inlet to the box should be at least 1 inch above the outlets. Precast distribution boxes can be purchased from septic tank dealers.

Standard trench disposal system

The standard trench method of effluent disposal consists of two or more equal-length flat-bottom absorption trenches not more than 100 feet long (trenches 60 feet or less are preferred). Perforated plastic pipe or open-joint agricultural drain tile in the bottom of the trenches serves as a conduit for the effluent from the treatment tank. The liquid seeps out of the holes in the pipe and is absorbed by the soil. A layer of gravel under the drainpipe facilitates the uniform spreading of the effluent over the entire absorption area.

The maximum acceptable slope on which a standard trench system can be installed is 25 percent. For slopes between 15 and 20 percent, a detailed engineering design must be prepared and submitted with the application for the permit. On slopes from 20 to 25 percent, the system must be designed and the installation supervised by a qualified registered professional engineer.

How to construct standard trenches

Determine the number of square feet of absorption area needed for each bedroom (Table 2). Multiply this figure by the number of bedrooms to determine the total number of square feet of trench bottom required. Divide this total number of square feet by the width of the trench to determine the linear feet required. Any width of trench between 12 and 36 inches that is convenient to construct may be used. Wider trenches can be shorter and will require less pipe.

Drive stakes to mark the center line of the trenches. If the lot is level, they can be in a straight line; if not, they should follow the general contour of the sloping land.

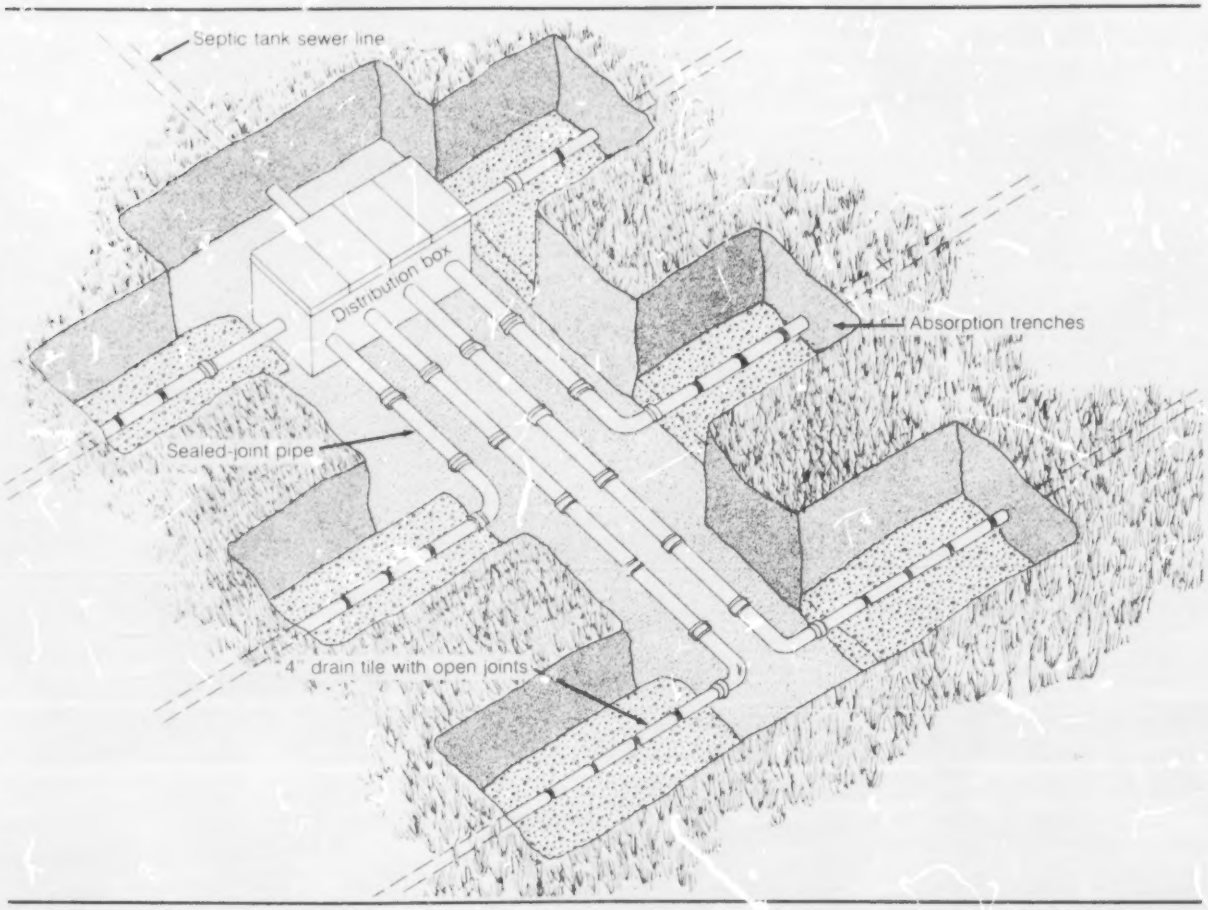


Figure 13 Multiple outlets in a distribution box at the end of the septic-tank sewer distribute the effluent uniformly to absorption trenches in the disposal area.

The trenches should be at least 5 feet apart from wall to wall.

Dig the trenches 24 to 36 inches deep. Be sure they are nearly level, both across the bottom and from end to end. A surveyor's tripod level will make this job easier. If the trenches are opened with a backhoe, the high spots in the bottom of the trenches should be leveled with a spade.

Set grade stakes in the middle of each trench and drive them down so that a string line across the tops will establish a grade of 2 inches of fall in 50 feet. Place 1- by 6-inch straightedge boards on edge in each trench and nail them to the grade stakes, parallel to the string line and even with the tops of the stakes.

Place coarse gravel or crushed stone, 1/2 to 2 1/2 inches in diameter, up to the tops of the boards. Leave the grade boards in place.

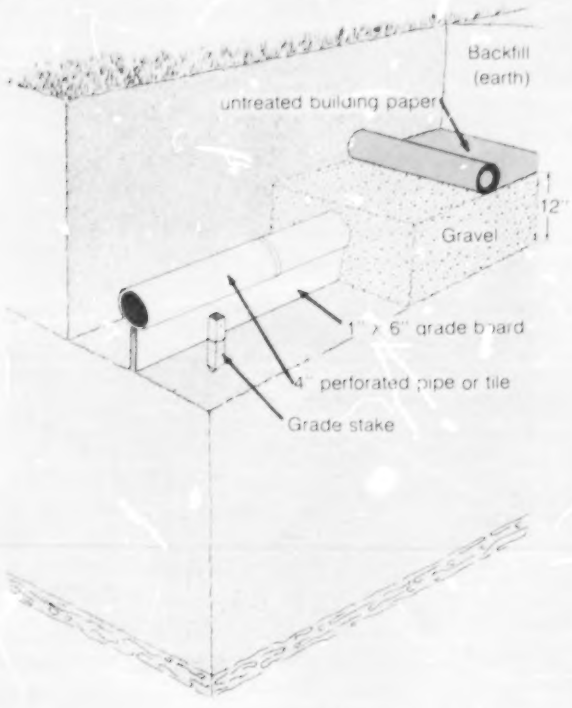
Lay the drainpipe on top of the grade boards. If 1-foot sections of clay tile are used, butt the ends as close together as possible. Cover the open joints with strips of asphalt-treated building paper. If perforated plastic sewer pipe or coiled plastic tubing is used, be sure the holes are turned down.

Place more stone over and around the pipeline until the gravel bed is at least 12 inches deep. When dumping the stone, be careful not to break the pipe or knock the short sections of tile out of line.

Place a strip of untreated building paper or a layer of straw over the stone and backfill the rest of the trench with the soil just removed. Lightly compact loose soil in the trench, but do not tamp wet clay because it will harden like concrete and retard evaporation.

Do not permit trucks or tractors to travel over the disposal field after the trenches are filled. Heavy machinery may crush the pipe and block the flow of effluent.

Do not plant trees or shrubbery in the disposal area. Roots searching for moisture may develop a mass of tiny, hairlike roots inside the pipe, plugging the drain line and causing that part of the system to fail.



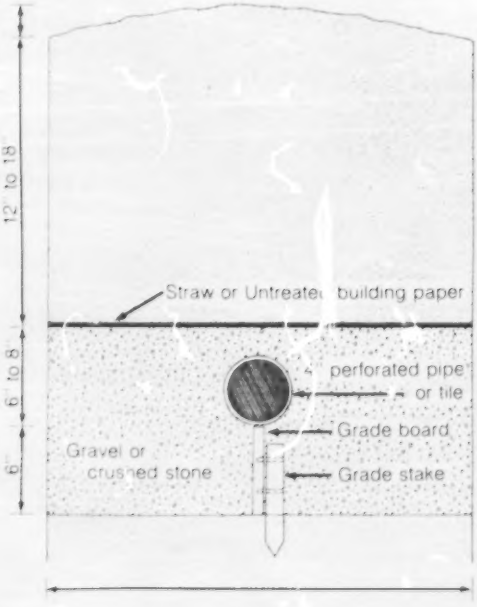


Figure 14 When constructing disposal trenches, attach a board to grade stakes in the bottom of the trench to provide uniform slope for the distribution line. Gravel or crushed stone permits the liquid to spread evenly and increases the storage capacity of the absorption trench.

Figure 15 Prevent heavy vehicles from driving over the septic tank, sewer pipe, or distribution lines in the effluent-disposal area.

Figure 16 Do not place tile lines near trees or plant trees near the absorption trenches.

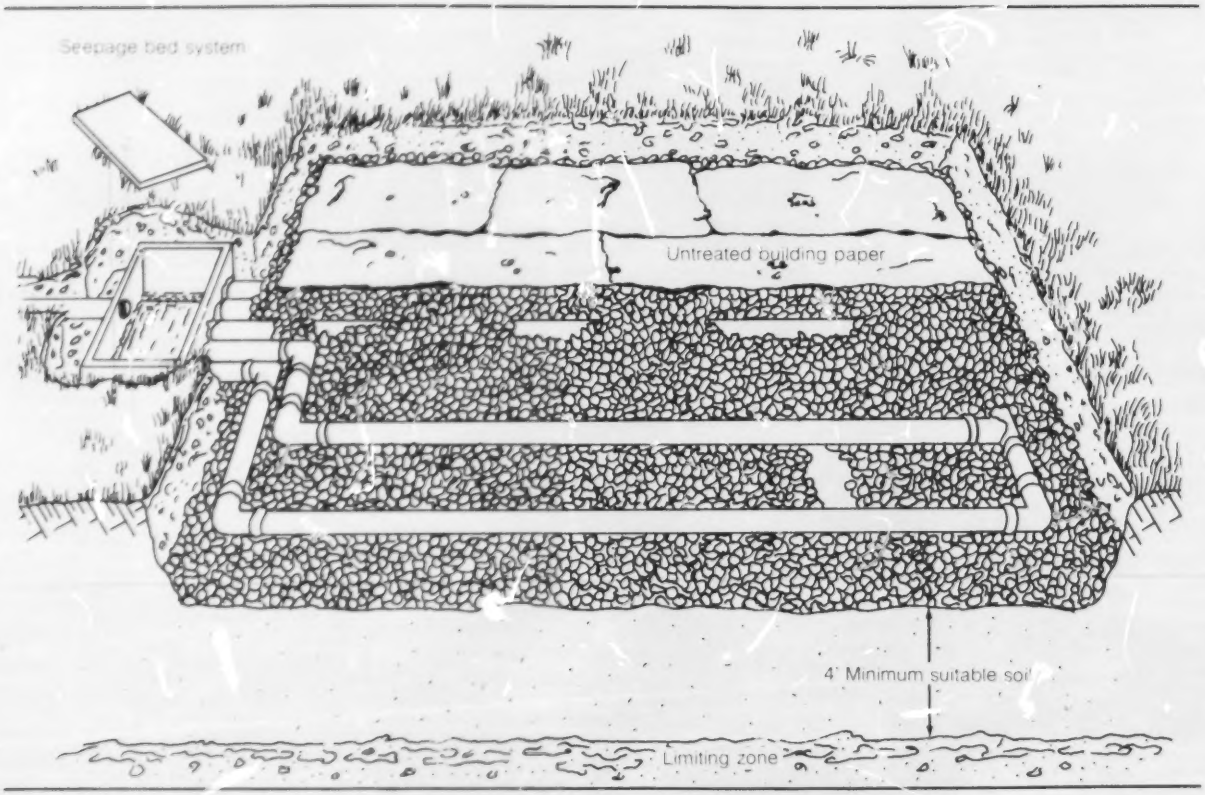


Figure 17. A seepage bed makes more efficient use of the space available for effluent disposal on a small lot.

Effluent-seepage bed

The conventional effluent-seepage bed may be more convenient and economical to construct than standard trenches with an equivalent absorption area.

A seepage bed can make more efficient use of available space than can a series of standard trenches with strips of unused land between them. A seepage bed is normally recommended where space is limited and the natural slope does not exceed 8 percent. A bulldozer or front-end loader can be used to excavate a seepage bed, but a backhoe is more appropriate for digging narrow trenches.

The procedure used for installing a seepage bed is similar to that used for standard trenches. A distribution box may be required, depending on the design of the system and the layout of the effluent-distribution lines.

Calculate the total square feet of absorption area based on the soil-percolation rate (Table 2) and the number of bedrooms. Determine the most desirable dimensions of a seepage bed for the lot.

Stake out the area and excavate the soil to a depth of 24 to 36 inches. Level the bottom carefully.

Determine the location of the lateral distribution lines. They must be not more than 6 feet apart and no closer than 3 feet to the side wall. Use a 1- by 6-inch board nailed to grade stakes to support the perforated pipe on a level plane.

Cover the bottom of the bed with crushed stone or coarse gravel up to the top of the board. Lay the perforated pipe in position. Add stone or gravel to a depth of at least 12 inches, covering the distribution lines.

Place a layer of untreated building paper over the stone and replace the soil taken from the excavation. The bed should have at least 12 inches of topsoil over the paper and stone, and it should be mounded slightly to allow for settling.

Serial distribution

Some authorities recommend a method of effluent disposal known as serial distribution for moderately steep slopes.

The typical serial-distribution system consists of a series of interconnected disposal trenches. The trenches may be straight and parallel, or they may follow the contour. The pipe in each trench is connected to the one in the adjacent trench by a tight-joint relief line. Effluent from the treatment tank fills the first trench and then the excess overflows through the relief line into the next trench in the series.

Serial distribution requires the same amount of absorption area as tile trenches or seepage beds, but it does not depend on equal distribution of the effluent to all disposal trenches. It eliminates the need for a distribution box and much of the tight-joint pipe between the box and the disposal trenches.

If a serial-distribution system is to be constructed on a 15- to 20-percent slope, a detailed engineering design must accompany the application for a sewage permit. If installed on a 20- to 25-percent slope, the system must be designed and constructed under the supervision of a registered professional engineer.

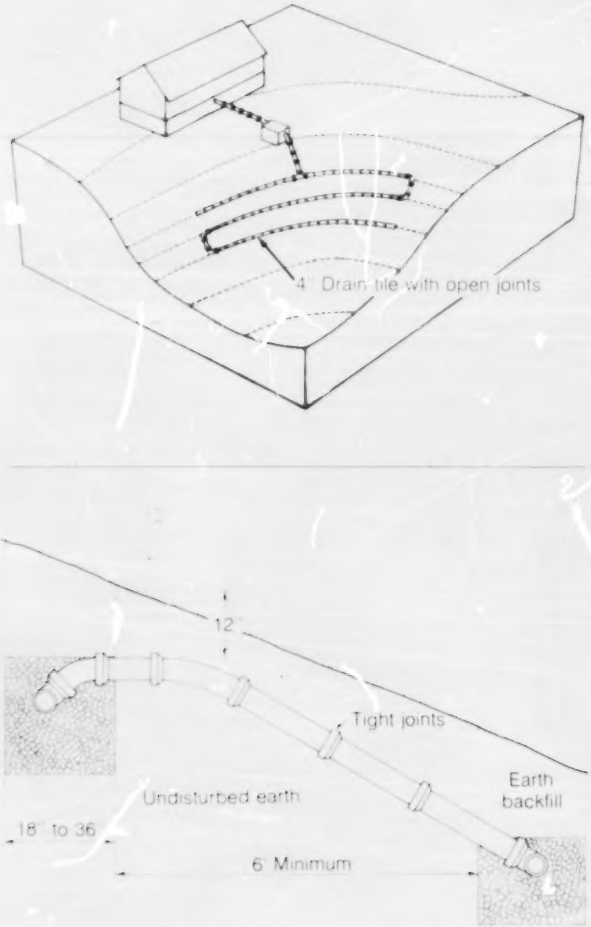


Figure 18 Serial distribution is a method of effluent disposal suitable for hillsides or sloping land. It eliminates the need for a distribution box and reduces the amount of sealed-jointed pipe required.

How to design a serial-distribution system

Determine the size of the absorption area from soil-percolation tests (Table 2) and the number of bedrooms in the home.

Dig the trenches about 2 to 3 feet deep in any convenient width from 18 to 36 inches leaving 6 feet of undisturbed earth between trenches.

Level the bottoms of the trenches and place grade boards in position with a slight grade toward the outlet end. Be sure that the fall is in opposite directions for succeeding trenches.

Place coarse gravel or crushed stone in the trenches to the top of the boards and lay the perforated pipe on the board. Connect the distribution lines in adjacent trenches with overflow or relief lines (Fig. 18). Cover the pipe with additional stone or gravel and complete construction of the trenches.

The relief lines should be 4-inch tight-joint sewer pipe with direct connections to the pipe in the seepage trenches, as illustrated. These relief lines should be laid at the opposite ends of the trenches to prevent short-circuiting.

ALTERNATE METHODS OF EFFLUENT DISPOSAL

Since much of Pennsylvania's land area available for residential development is not satisfactory for conventional on-lot sewage-disposal methods, a potential home builder whose lot is in a marginal category may find that an alternate effluent-disposal system can solve his problem. Alternate systems approved by the DER include elevated sand mounds, sand-lined beds and trenches, oversized areas, and shallow placement areas. Information about permissible soil and site conditions as well as construction details can be found in a separate publication entitled *Alternate Methods of Effluent Disposal for On-Lot Home Sewage Systems*. This publication, prepared by the Extension Service in cooperation with DER, is available from County Extension Offices, DER offices, and certified sewage-enforcement officers.

The use of alternate systems is restricted to those specific situations where conventional disposal methods are prohibited, and where soil, geologic, and topographic conditions are suitable for these types of disposal facilities.

Elevated sand mound

An elevated sand mound is simply a mound of sandy fill material piled on top of the ground. This sandy material serves as a filter and a medium in which sewage effluent is filtered and the biological organisms are inactivated before the effluent seeps into the soil.

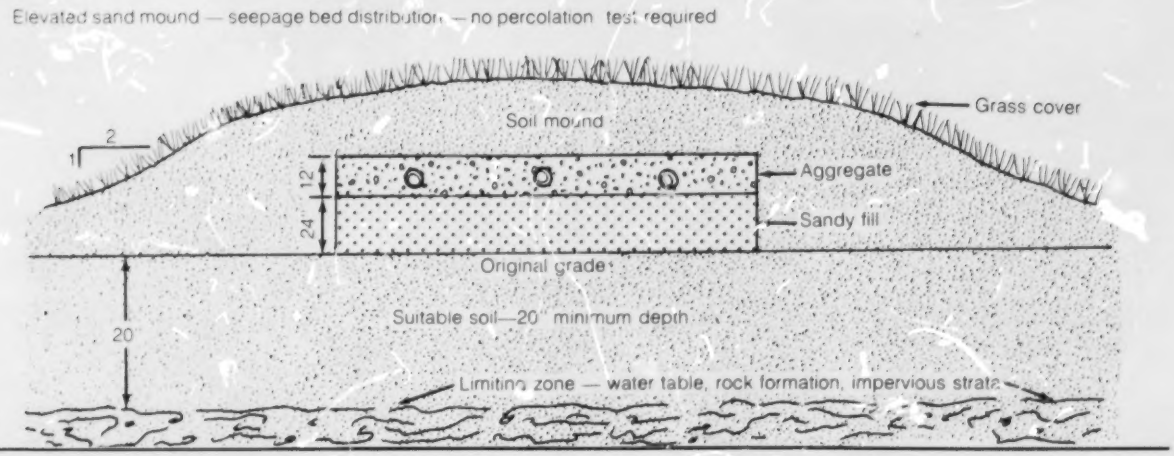


Figure 19 Elevated sand mound – seepage bed distribution.

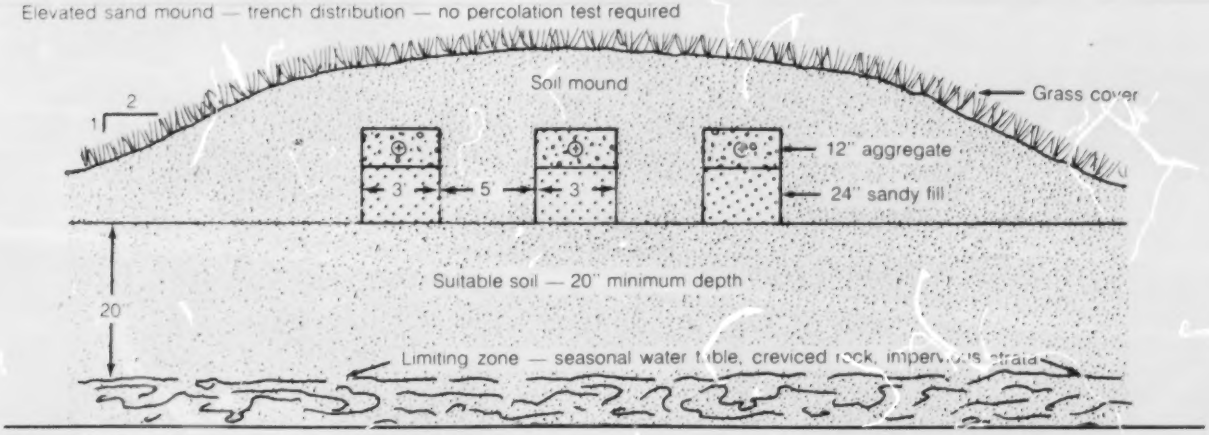


Figure 20 Elevated sand mound – trench distribution.

Permissible conditions. An elevated sand mound may be used for a newly constructed home or to correct an existing malfunctioning system. It cannot be used on a flood-plain soil or any soil that is considered somewhat poorly to very poorly drained. It cannot be used where the limiting zone (seasonal water table, rock formation, or impervious strata) occurs within 20 inches of the soil surface. The maximum natural slope on which an elevated sand mound using seepage-bed distribution (Fig. 19) can be constructed is 8 percent. If the mound uses a trench-distribution system (Fig. 20), a maximum slope of 12 percent is acceptable.

Size of mound. The effective size of a mound or the absorption area covered by sand should be calculated on the basis of 330 square feet per bedroom. If an aerobic tank is used, the basis is 220 square feet per bedroom.

Sand specifications. The sandy fill material used to construct an elevated sand mound is the rough equivalent of dirty sand or riverbank sand. DER specifications indicate that the clay content must range from 5 to 15 percent by weight, and the coarse fragments larger than 1/4 inch must not exceed 15 percent by volume. Sand of this quality is difficult to find and very expensive.

Sand-lined beds and trenches

This alternate method of effluent disposal differs from an elevated sand mound in that instead of above ground, the sandy fill material is placed in a pit or an excavation below the natural surface (Fig. 22).

Permissible soil and site conditions. This disposal system may be used on sites with very well drained soils where the percolation rate is less than 6 minutes per inch, or where the porous layer is less than 4 feet below

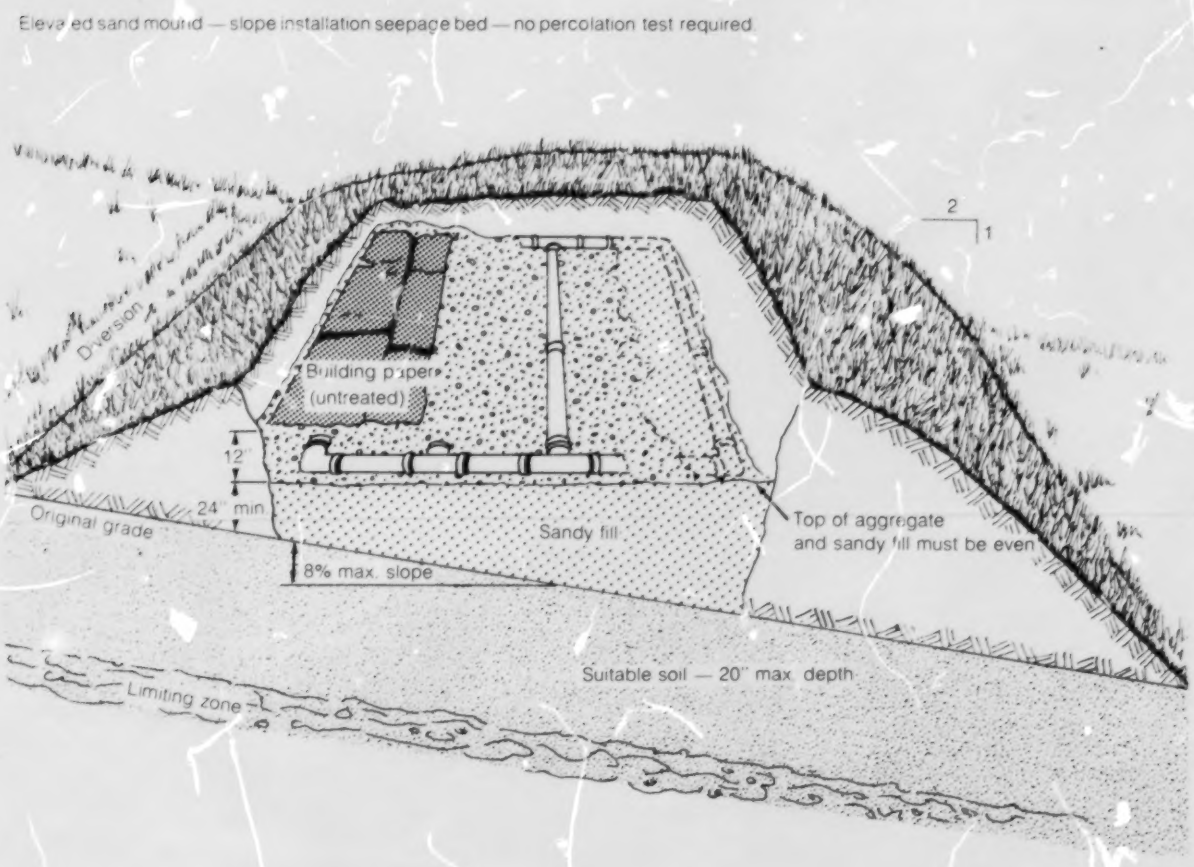


Figure 21 Elevated sand mound – slope installation seepage bed.

the ground level. This method cannot be used on floodplain soils or soils with restrictive permeability.

The natural slope of a site on which this alternate system can be used varies with method of effluent distribution. Seepage beds may be used on slopes not exceeding 8 percent, while trenches may be installed on slopes ranging up to 25 percent. On slopes from 20 to 25 percent, the system must be designed and the construction supervised by a registered professional engineer with expertise in this field.

Size of absorption area. The size of the sand-filled absorption area is the same as for an elevated sand mound — 330 square feet per bedroom for a septic tank system and 220 square feet per bedroom for an aerobic tank system.

Oversized absorption area

If a conventional effluent-disposal field cannot be permitted on a site because of a slow percolation rate, an oversize absorption area may be considered for an alternate method of effluent disposal.

Soil and site considerations. The oversize area can be used only on sites with deep soils where the percolation rate is greater than 60 but less than 90 minutes per inch. If a subsurface limiting zone is present, it must be at least 4 feet below the bottom of the aggregate that will be placed in the absorption bed or trench.

Size of absorption area. The size of the absorption area for this disposal method must be based on 425 square feet per bedroom. A septic tank is not permitted, and an aerobic-treatment tank is required. Reducing the

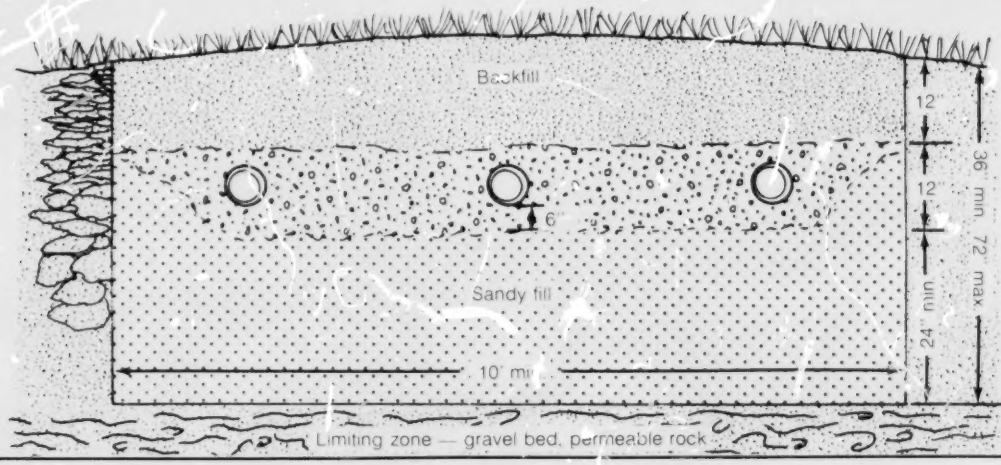


Figure 22 Sand-lined bed.

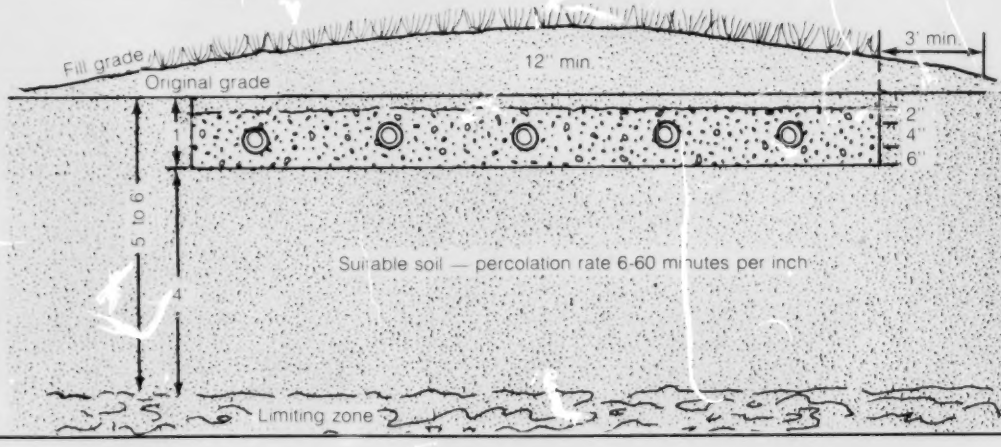


Figure 23 Shallow placement area.

size of the absorption area normally permitted for aerobic tanks does not apply in this situation.

Shallow placement absorption area

The shallow placement absorption area (Fig. 23) as an alternate method of effluent disposal may be a possibility for new homes constructed on sites where the limiting zone begins between 5 and 6 feet below the surface. This method cannot be used to correct a malfunctioning system for an existing residence. The percolation rate on the site must range between 6 and 60 minutes per inch.

Size of absorption area. The size of the absorption area must conform to established standards for conventional standard trenches and seepage beds. Such standards are based on a site investigation, soil-percolation tests, and the number of bedrooms served.

Other considerations. The site used for the absorption field must have a minimum of 12 inches of suitable soil placed over the gravel aggregate, and this cover must overlap the entire system by 3 feet on all sides. All surface run-off must be diverted away from the area.

If the standard trench distribution system is used, the minimum natural slope of the site must not exceed 15 percent. The bottom of the gravel aggregate must be at least 12 inches below natural grade. If the seepage bed is used, the maximum permissible slope is 5 percent, but the minimum depth to the bottom of the aggregate at its lowest side must remain the same (12 inches).

If serial distribution is used, the maximum natural slope permitted is 20 percent, and the minimum depth below natural grade to the bottom of the aggregate must be 16 inches. The system must be designed by a registered professional engineer.

THINGS YOU SHOULD KNOW ABOUT SEWER LINES

The house sewer is a pipeline conveying sewage from the house to the treatment tank and from the tank to the final effluent-disposal area. It should be at least 4 inches in diameter and should have a slope of about 1/8 to 1/4 inch per linear foot. Sewer lines should be constructed of bell-end sewer pipe made from cast iron, vitrified clay, concrete, or plastic. All joints must be watertight and root-proof. Local municipal plumbing codes may specify which type of pipe can be used.

Tile or concrete pipe
If regular clay tile or concrete tile is used, the bell joint between two pieces of pipe must be sealed and root-proofed with an asphalt mastic compound. Use a swab to remove any excess sealant from the inside of the tile joint. Most of the vitrified clay tile currently available for sewer lines is equipped with a special slip-ring gasket that makes the joint both watertight and root-proof, and does not require a mastic seal.

Plastic pipe
There are several types of rigid and flexible plastic pipe that can be used for sewer lines and effluent-disposal systems. ABS and PVC types are the most popular. These types can be joined with chemical solvent or slip-joint coupling, depending on whether a watertight joint is required. Plastic pipe should not be used under driveways or in areas that will be crossed by heavy vehicles or farm equipment. If such traffic areas cannot be avoided, use a crush-resistant culvert if available, or cover the pipe in the trench with at least 2 feet of earth.

Y-branch cleanout
Install a Y-branch cleanout pipe-fitting in the basement so that obstructions between the house and septic tank can be removed without digging up the pipe. Additional cleanouts should be installed every 50 feet, or wherever the sewer makes a 90-degree change in direction of flow. Always use two 45-degree ells to make a long sweeping turn, rather than an abrupt 90-degree turn. Mark the location of each underground cleanout with a permanent marker on the ground surface.

Make a sketch of your underground system
You can save yourself much worry and grief if you make a sketch showing the location of the septic tank, the sewer, the cleanout joints, the distribution box, and the tile lines in the effluent-disposal field. Use the back cover of this publication to make your sketch. It should be filed with your deed or other important papers for safekeeping and future reference.

REFERENCES

Information in this publication has been adapted from the following publications available from:

The Department of Environmental Resources, P.O. Box 2063, Harrisburg, Pennsylvania 17120

The Pennsylvania Sewage Facilities Act (Act 537)

Technical Manual for Sewage Enforcement Officers

Rules and Regulations, Chapter 71, Administration of Sewage Facilities Program

Rules and Regulations, Chapter 73, Standards for Sewage Disposal Facilities

The Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

Manual of Septic Tank Practice, Public Health Service, Publication No. 526

The National Sanitation Foundation, P.O. Box 1468, Ann Arbor, Michigan 48106

Standard No. 40, Relating to Individual Aerobic Wastewater Treatment Plants

Cooperative Extension Service, The Pennsylvania State University, University Park, Pennsylvania 16802

Special Circular 214, Alternate Methods of Effluent Disposal for On-lot Sewage Systems

GLOSSARY

Aerobic sewage-treatment tank A water-tight receptacle designed to receive raw sewage from the house and provide an environment for decomposition and stabilization of the organic material prior to the discharge of the liquid component. Inlcudes some mechanical means of introducing air to provide oxygen for aerobic organisms and processes.

Alternate system An individual on-lot sewage-treatment system, including treatment tank and an alternate subsurface absorption area.

Certified sewage-enforcement officer A person qualified by training and examination and certified by the Department of Environmental Resources Certification Board to perform the designated duties of sewage-enforcement officer.

Conventional method of effluent disposal A subsurface method of sewage effluent disposal, using a standard absorption trench, seepage bed, or serial distribution system.

Conventional system An individual on-lot sewage-treatment system that includes either a septic tank or an aerobic-treatment tank and a conventional method of subsurface effluent disposal.

Limiting zone Any horizon (layer) in the soil profile that restricts the downward movement of liquid sewage or limits the proper renovation of sewage effluent; inlcudes any impervious strata, rock formation, mottled soil condition, water table, gravel layer, or rock with open joints and solution channels.

Local agency A municipality or any combination of municipalities acting cooperatively or jointly under the laws of the Commonwealth, county, or county department of health.

Lot A parcel of land used as a building site or intended to be used for a building site at some time in the future.

Mottled soil condition The word "mottled" means marked with spots of color. Mottling in the soil refers to the varicolored streaks or spotty color patterns within a soil profile — usually indicating poorly drained soil or a seasonal high water table.

Municipality A city, town, township, or borough.

Percolation test A procedure used to estimate the rate of vertical movement of sewage effluent down through the soil in a proposed subsurface disposal area; also used to determine area needed for the disposal system.

Rural residence A structure occupied or intended to be occupied by not more than two families on a tract of land of ten acres or more.

Septic tank A water-tight receptacle which receives raw sewage from the house and holds it for a brief period during which anaerobic organisms decompose the organic solids and convert the sewage to a mass of scum, sludge, and liquid waste.

Sewage A substance that contains any of the waste products, excrement, or other discharge from human beings or animals. Normally includes wastewater from kitchen and laundry.

Sewage-enforcement officer (SEO) An official or employee of the local agency who reviews applications for sewage-disposal permits, and who conducts investigations and inspections necessary to implement the rules and regulations of the Pennsylvania Sewage Facilities Act.

Soil horizon A layer of soil approximately parallel to the soil surface with identifiable characteristics created by soil-forming processes.

Soil profile A composite view of a vertical section of the earth showing the natural organic layers on the surface, the genetic horizons, and the parent materials from which the layers of soil were derived.

Soil-profile inspection An inspection procedure used to locate and identify subsurface limiting zones in a potential sewage-effluent disposal area.

Treatment tank A water-tight receptacle designed to retain sewage for a period of time during which bacteriological decomposition of the solids takes place; includes septic tanks and aerobic-treatment tanks.

MAINTENANCE RECORD

Date	Work completed	Who did the work

LAYOUT PLAN OF YOUR ON-LOT SEWAGE SYSTEM

Installer _____ Date _____